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Measurement of Returns to Adult Education: Morbidity Effects on Wage Rates in Côte d'Ivoire and Ghana

T. Paul Schultz

Aysit Tansel

YALE UNIVERSITY

Box 1987, Yale Station
27 Hillhouse Avenue
New Haven, Connecticut 06520

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T. Paul Schultz
Yale University

Aysit Tansel
Yale University
and
Middle East Technical University - Turkey

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ABSTRACT

Sickness should make individuals less productive by reducing their capacity to do work. Measurement of this effect of morbidity on productivity involves several measurement problems. First, there is no consensus on how to measure adult morbidity in a household survey of a low-income population. Second, if part of earnings is used to improve health, how is the impact of morbidity on productivity inferred? To consider the first problem, surveys from Côte d'Ivoire and Ghana are examined to assess whether self-reported functional activity limitation due to illness is a reasonable indicator of morbidity for wage earners. In both countries this form of morbidity is about one day in the last four weeks and varies in a plausible manner. To deal with both the measurement and joint determination problems, an instrumental variable estimation approach using local food prices and public services is implemented for assessing how morbidity impacts on wages and earnings. These estimates indicate that morbidity is linked among men to declines in hourly wage rates, and associated with reduced hours of work for wages, and a reduced probability of entering the wage labor force. Among much smaller samples of wage earning women, the patterns between morbidity and wage rates and time allocation are not uniform or statistically significant.

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1. Introduction

The economic consequences of secular improvements in the health status of a population are thought to be beneficial, but the empirical measurement of this economic benefit of reducing morbidity is complex and most evidence on the relationship is arguably biased. This paper develops an econometric approach to estimating without bias at the individual level the effect of adult morbidity on labor productivity, and also reports evidence of the association of morbidity with labor supply, although the latter relationship is more difficult to interpret, as discussed below. Neglecting the social valuation of the private pain and suffering of the sick and the welfare losses morbidity imposes on kith and kin, the effort here to assess the economic productive consequences of morbidity is clearly a lower bound on the personal welfare losses caused by poor adult health.

The lack of a consensus about the relationship between mortality and morbidity in populations is discussed in section 2 to indicate that measurements of morbidity are controversial and rarely studied in low income countries in juxtaposition with economic behavior. A framework for thinking about the statistical determinants and consequences of adult health is developed in section 3.[1] The incidence of health problems in West Africa is briefly described in section 4 before self-reported morbidity levels are summarized from surveys of Côte d'Ivoire and Ghana. Section 5 reports estimates of wage, hours, and earnings functions in which the effect of morbidity is evaluated. Section 6 briefly concludes this exploratory study. It is a tentative first step toward documenting, in a suitable simultaneous equation framework, how variation in adult health might affect social productivity in low income populations.

2. Measurement of Morbidity and its Relation to Mortality

Mortality and morbidity are believed to be determined by similar social, economic and technical factors. The reduction in mortality caused by the increasing control of infectious and parasitic diseases in

[1]Because infant and childhood death rates are demonstrably high, and the proportion of the population in these young age groups is relatively large, due to high fertility rates, childhood diseases and illnesses have received the greatest attention in African public health initiatives in the last decade.

In a continent where women have received a small fraction of the basic education allotted to men, maternal health and education programs have also begun to receive priority (Schultz, 1988). Adult morbidity and diseases are expected to receive increasing study in the 1990s as health priorities shift (Jamison and Mosley, 1991).

the 20th Century is thought to have improved rapidly the health of the world's low income populations, and narrowed the difference between the expectation of life at birth for low and high income countries (Omran, 1971; Preston, 1980). But, because morbidity or health is difficult to measure, alternative interpretations of the evidence are also presented.

Some have argued that morbidity increases with social and economic development, despite the fact that age specific mortality decreases (Riley, 1990). Some time series on mortality and morbidity from preindustrial European populations suggest that an inverse relation may exist, due hypothetically to heterogeneity in the innate healthiness of populations (Alters and Riley, 1989). This hypothesis implies that when survival rates increase, the proportion in the population of innately less healthy individuals also increases, and the incidence of non-lethal illnesses increases. This "health heterogeneity" hypothesis may be more relevant to appraising the impact of life sustaining medical high technology on morbidity in contemporary high income aging populations, where expected years of life can increase without necessarily increasing the length of disability-free life (Crimmins, et al., 1989).

Self-reported morbidity or health status is probably subjectively affected by an individual's social and cultural background given his or her objective clinical health. This "cultural conditioning" provides an alternative explanation for why reported morbidity rates sometime increase over time while the expected length of life is increasing. The cultural conditioning view of the health transition emphasizes that the threshhold of what is considered "good" health also varies systematically across a society; individuals from more educated, wealthy, and socially advanced groups have a heightened sensitivity to the limitations imposed on them by their health status. They will therefore have an increased propensity to report themselves and their family as being ill or in poor health, holding constant for their objective or clinically confirmed health status. According to this view, self-reported morbidity in low income countries may not be a useful indicator of healthiness or an appropriate guide for the design of public health policy. For example, educated elite may report themselves as more often ill than the clinically much less healthy rural uneducated poor in the same society. The health transition approach does not deny the potential relevance of clinical morbidity in setting some health priorities, but cautions against relying on subjective self reporting of health from household surveys (Johansson, 1991; Caldwell 1990).

<u>Issues and Tradeoffs in the Measurement of Morbidity</u>

The epidemiological literature devoted to the measurement of morbidity has two primary objectives. First, what self-reported health status questions reliably replicate the distribution of clinically confirmed indicators of health status? Large representative surveys using such questions would then become a much less costly means for studying health than analyses involving medical specialists. Second, what self-reported indicators of health status have the greatest "power" to test statistically hypotheses about the relationships between health status and behavior? As discussed below, these two objectives may conflict, and thus define a trade-off that requires more study. Moreover, most studies on the measurement of morbidity are based on surveys from high income countries and focus on chronic disabilities among the elderly. It is doubtful that the problems of measurement of acute spells of morbidity among labor force aged adults in low income countries are similar to those of the elderly in high income countries that reflect chronic disabilities brought on often by degenerative diseases. There is, thus, much room for new research on how to design adult health status questions for use in the understanding of health conditions and in the evaluation of health policies in developing countries.

Self-reported functional activity limitations are more reliable indicators of clinically confirmed health status when they relate to more <u>specific</u> functional activity limitations,[2] rather than more general <u>role</u> activity limitations (Steward, et al., 1987).[3] On the other hand, studies report that the statistical "power" to test hypotheses is higher if measures of functional limitation relate to a more common occurrence, such as inability to climb stairs, rather than a more severe and rarer limitation, such as inability to walk (Rogers, et al., 1979). This suggests that a more common functional activity limitation may be preferred here for statistical modeling, whereas replicability is greater if the condition reported is more restrictively detailed and rarer. In the Living Standard Surveys of Côte d'Ivoire and Ghana the health module (4Q1) asks "Have you had any illness or injury during the past four weeks?" This is followed up if answered affirmatively by an inquiry of "How many days during the past four weeks did

[2]More detailed limitations related to self care (e.g. feeding, toilet), mobility, and physical activities (e.g. running, walking, climbing stairs, etc.). But these functional limitation variables have been designed to measure chronic health conditions among the disabled, and their usefulness to assess acute health conditions as a limitation on engaging in productive work is infrequently mentioned in the literature.

[3]For example, inability to engage in regular activity, such as work, housework, or school work. The objective here is to narrow the circumstances in which the role activity limitation is measured so that it reflects a threshold level of cost (foregone wage payment) that is objectively related to the economic productivity and general wealth of the individual.

you suffer from this illness or injury?" Then the questionnaire asks "For how many days during the past four weeks were you unable to carry on your usual activities because of this illness or injury?"[4]

The duration of illness in the last four weeks is assumed to contain more information about health status than merely the occurrence (binary) of such an event.[5] Illness is considered here, only if it is severe enough to prevent the individual from working. The line between inactive and active health status is believed to be subject to more subjective variation where the individual's "usual activity" is within the household (housework) or working as an unpaid family worker, schooling, or even as a self employed, where the tasks undertaken or routines carried out may be voluntarily adapted to an individual's current physical health limitations (see Pitt, et al., 1990). Because we expect these self reported health limitations on work to be subject to greater response error for the self employed and family workers than for wage earners, the response of only the wage earners are exploited here to estimate how morbidity varies across localities and households in the sample. To repeat, the variable analyzed in this paper is the number of

[4]The LSMS questionnaire then asks individuals whether they consulted a health worker, what kind, and at what cost, and what treatments were provided. The health economics literature treats the demand for medical care as potentially determined by household income, endowments, and community prices. However, the demand relationships are often estimated from a selected sample of survey respondents who classify themselves as having been sick in the reference period (Akin, et al., 1985; Gertler, et al., 1987). This leads to estimating conditional demand functions, which would seem justified only if having an acute illness is independent of preferences and unobservables, as well as prices of health inputs and income, that might influence choice of medical care. A puzzling finding in some conditional demand studies is that community prices of, or access to, medical care have little effect on demand for health care (e.g. Akin, et al., 1985). The incidence of self-reported morbidity may itself be affected by past health care prices and access, which could then modify the incidence of current acute conditions (i.e. selection into the sample) by affecting past investments in preventive and curative care. A downward bias in the estimate of the price effect on health care demand may, therefore, be induced by this method of selecting the sample for estimation purposes that is not uncorrelated with the previous periods' health inputs, C, and preference orderings for health and other goods, captured in ε_1 (see subsequent model).

[5]This measure of illness has the property that spells of illness may not be complete. Censoring of the duration of continuing illnesses at the date of the survey can be assessed by 5AQ13 regarding whether the individual is unable to look for work during the past seven days because of sickness (1) or handicap (2). Censoring of spells that continued into the last four week period can be assessed by 4Q2 on how long ago did the illness start. The distribution of spells by duration could also be studied within subsamples of the LSMS that are reinterviewed in a subsequent year's survey. With such repeated observations on individuals (assuming individual identification codes from the various round plausibly match, i.e. the person has similar demographic characteristics -- age, sex, birthplace, marital history, etc.) the serial correlation structure of the explained and unexplained propensities to be ill can be estimated. The welfare implications might be quite different depending on whether the occurrence of illness is concentrated in relatively brief spells for many persons that are independently distributed through time, or associated with longer spells of illness for fewer persons that are likely to recur for these certain individuals, or are chronic conditions. The Côte d'Ivoire survey provides such a panel structure, whereas the panel structure designed into the Ghana survey appears not to have been retained in the coded file of the survey in the first two years.

days in the last four weeks that the individual is unable to work due to illness, for individual's whose primary employment is a wage or salary job.

Another reason that self employed workers are not analyzed is that they have a more difficult task of reporting their hourly earnings than do wage earners. Because, both the disability and wage variables are needed for estimating this model, the principal focus is on wage earners, even though the self-employed and family workers constitute the majority of the population in most low income countries. This restricted measure of functional activity limitation of wage earners should minimize response bias and bias due to errors in measurement of morbidity, but may introduce sample selection bias.

3. A Model of Health Production and Productivity

The consumer maximizes a single period utility function:

$$U = U(h, I, C, Z, H_2) \ , \tag{1}$$

where h is current health status, I and C are endogenous health inputs and care, Z is a non-health related consumption good, and H_2 is time allocated to nonwage activities, subject to budget and time constraints:

$$\begin{aligned} F &= ZP_z + CP_c + IP_I = wH_1 + V \\ T &= H_1 + H_2 \ , \end{aligned} \tag{2}$$

where F is the consumer's income, and savings is ignored in this single period framework, P's are prices, w is the market wage rate, V is wealth income, T is total time available and H_1 is wage work.

Health is assumed to affect productivity by a two-stage process. A cumulative health status of an adult, N, is a function of cumulative nutrition, activity levels, preventive and curative health care received over a lifetime, C, and an exogenous health endowment that is not affected by behavior, G, and an error ε_1:

$$N = N(C, G, \varepsilon_1) \ . \tag{3}$$

Long term health status might be approximated by height and an intermediate to short-run indicator of nutrition could be a body-mass index (BMI = weight in Kg./height in m.^{2}) (Tanner, 1981; Waaler, 1984; Fogel, 1991). The literature on nutrition suggests that adult height is substantially determined by the diet and disease conditions of a child before age four, including their period of uterine development

(Martorell and Habicht, 1986; van Wieringen, 1986). Thus, height may be viewed as an indicator of early child health investments and conditions, and treated, as with schooling, as if it were modified by the child's parents and childhood community environment. The body-mass index, however, is more of an indicator of the individual's contemporaneous circumstances, and varies with long term life-cycle career success, seasonal cycles in the cost and return to nutritional inputs and outputs, and perhaps seasonal variation in exposure to disease. These two indicators of stunting and wasting, respectively, due to a combination of diet, disease, activity levels and health care, appear to modify mortality rates within an age and sex group (Waaler, 1984) and have been used to represent health status of adults in the cross section and over time (Tanner, 1981) and to explain the growth in labor productivity in Western Europe since the industrial revolution (Fogel, 1991).

Self reported health status, the second stage, h, is influenced by current inputs to health, I, including exogenous local climate and disease environment, and the previous period's health/nutritional status:

$$h = h(I, N, \varepsilon_2) = h'(I, C, G, \varepsilon_1, \varepsilon_2) \tag{4}$$

where ε_2 is a second error, and $h(\cdot)$ could be viewed as a dynamic structural equation, and $h'(\cdot)$ represents the final form for the health production technology.

Health status is approximated here by the self reported number of days in the last four weeks that illness prevented the individual from working. This self-reported indicator of health, h, diverges from the health status, h*, by a measurement error, e. That error will be viewed here as a random variable uncorrelated with the other determinants of health or behavior. Alternatively, the measurement error could reflect the individual's cultural attitudes toward health, potentially affected by formal education, E (Johansson, 1991), and modified by institutional arrangements, A, surrounding work that could affect the costs to the individual of not working when ill (e.g. Brundage, 1930):

$$h = h^* + e \qquad \text{or} \tag{5}$$
$$h - h^* = f(E, A, \varepsilon_3).$$

The logarithm of an individual's wages per hour of work, W , is related to acquired skills, summarized here as education, E, and changes associated with aging and the accumulation of work experience, X (defined following Mincer [1974] as postschooling years = age − schooling − seven), and the objective health status:

$$W = W(E, X, h^{*}, \varepsilon_4) , \tag{6}$$

Labor supply, $L = \ln H_1$, measured as the logarithm of hours worked for wages in the previous year, is determined by another equation (7) that is specified as a function of the same arguments entering the wage function:

$$L = L(E, X, h^{*}, \varepsilon_5) . \tag{7}$$

The effects of these conditioning variables on the logarithm of annual earnings, Y, is then approximately the sum of the variables's derivatives in the logarithmic wage and hours equations, because $Y = W + L$:

$$Y = Y\ (E, X, h^{*}, \varepsilon_6) . \tag{8}$$

However, labor supply is also a choice variable over which the individual has some control, and the time that the individual does not work for wages is spent in nonwage employments or leisure, H_2, and could influence utility in equation (1). Therefore, hours and implicitly earnings equations are more appropriately interpreted as being a function of not only E and X, but also of the other exogenous variables that define the household's endowments, technological opportunities, relative prices, and health environment. In such a more realistic reduced-form specification of hours and earnings, in equations (7) and (8) there is no clear theoretical basis for identifying the effect of morbidity on labor supply or earnings. Only the effect of morbidity on wage rates in equation (6) can then be identified and estimated, without imposing additional structure on the process determining health and time allocation. We report below the partial effects on wages, labor supply and earnings under the simplifying and identifying assumption that technology and price variables observed for the community exert their influence on labor supply only in so far as they operate through measured morbidity.

In addition to the problem of statistically identifying the effect of health on labor supply, this effect includes several conceptually distinct components. First, increases in an individual's wage rate due to better health, according to equation (6), elicits an income-compensated response, that should theoretically increase the wage labor supply. Second, the wage gain is associated with an income effect that is weighted by hours worked in wage employment. This income effect would decrease wage labor supply, if nonwage activities are a normal good, as traditionally assumed when leisure is thought to be synonymous with nonwage activities. Third, improved health may increase the capacity to engage in work, perhaps by reducing the disutility associated with wage work or correspondingly reducing the utility associated with nonwage activities. The first and third effects of improved health would increase labor supply, whereas the second effect would decrease labor supply in proportion to hours of wage work. The effect of health on total labor supply, and hence on earnings, is thus an understatement of the productive benefits of health, because it ignores the value of the probable income-induced increase in nonwage activities.[6]

To estimate the determinants of wage rates, and the correlates of labor supply, or earnings, E and X and regional shifters are assumed to be exogenous, but h* is assumed to be affected by individual and household choices of some of the nutrition and health inputs, C, I, and G. Consequently, h* is expected to be correlated with errors due to unobservables that enter the empirical counterparts of equations (6), (7) and (8). To avoid bias, instrumental variable estimation methods are adopted. Statistical identification depends on the specification of some exogenous variables, S, that are correlated with h* but are excluded from (6), (7) and (8) or uncorrelated with the errors in these equations.[7]

$$h^* = h^*(E, A, S, \varepsilon_3) , \tag{9}$$

where

$$S = \{P_c, P_I, P_z, G, V\} .$$

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[6]The exception would be where nonwage activities as a whole are viewed by the average worker as an inferior good, and the demand for nonwage activities would decline as wealth increases. Because it seems implausible that nonwage activities are an inferior good, except perhaps for women who may seek greater independence in market work instead of household work, it is expected that proper decompositions of health effects into these three components would confirm that the aggregate effect of health on labor supply understates the welfare gains, particularly for prime aged males for whom the income effect is weighted by full time hours. It is not within the scope of the current paper to estimate a fully articulated family labor supply model and perform this decomposition of wage and health effects on labor supply.

[7]This estimation approach relies on the community variables being valid instruments. This implies that individuals do not migrate among communities in response to the community's healthiness, or people would be systematically sorted across communities and their unobserved preferences for health would be correlated with the instruments. Conversely, this approach implies that observable community health infrastructure is not allocated by the government in response to the average exogenous health endowment of the community, G, another unobservable for the researcher. These working assumptions must be maintained if community variables are to serve as exogenous instruments as outlined in the conclusion of Rosenzweig and Schultz (1983). In this paper, however, we do not estimate health production functions and health input demand equations. Essentially, input prices are only used as instruments for health outcomes -- morbidity -- in wage, hours, and earnings equations.

Because W, L and Y are only observed when the individual participates primarily as a wage earner, P = 1, a probit model is assumed to determine the sample selection rule:

$$\text{Prob}\ (P = 1) = \text{Probit}(E, X, P\text{'s}, A, V, G, \varepsilon_7)\ , \tag{10}$$

where ε_7 is normally distributed.

Wealth income, V, is a variable suggested by economic theory, that is expected to raise the individual's reservation wage and thereby reduce the probability of working primarily as a wage earner. This identifying variable is excluded from equations (6), (7) and (8) but included in the probit equation (10). Joint maximum likelihood methods are initially used for estimation (Heckman, 1979; Greene, 1981). The use of "instrumental variables" such as prices and wealth, to identify the one-way effect of adult morbidity on components of labor productivity also eliminates bias from errors in the measurement of h in (5), due to random factors.

Two features of this framework should be noted. The first is the simultaneous equation approach to evaluating the effect of morbidity on productivity: The demand for health inputs is likely to increase with income, while improvements in health status are likely to increase wages and perhaps hours worked in (6) and (7). The estimation of a wage equation that includes anthropometric measures of health status, h, will therefore be biased, by the feedback effect of income on health, probably overstating the one-way effect of health on productivity. Consequently, local prices of food were used by Strauss (1986) as instrumental variables for calorie consumption by family labor in a family farm production function. Deolalikar (1988) followed a similar approach for estimating the effect of health status on individual wages. The effect of h on labor productivity is therefore estimated in this study analogously by instrumental variable methods, where the identifying instruments, S, are local prices of food and medical inputs, local climate, and health infrastructure that modify the disease environment, and the time costs required to obtain medical care.

The second feature of this framework is that it provides a way to decompose the effect of health on wages and hours, subject to the pragmatic working assumption that labor supply is only a function of observed human capital endowments, including health. The primary payoff to health investments is to raise the marginal productivity of people. However, it is widely observed, at least for full time male participants, that wage increases tend to be associated with decreases in their hours of work per year (Pencavel, 1986). If the wealth effect associated with wage changes on labor supply is also negative in low income settings (Schultz, 1981), the gross effect of health on annual earnings underestimates the gain in productive potential associated with an improvement in health. Our measure of market wage gain due to health neglects the increase in leisure or home production that healthier full time workers are likely to consume.[8]

In addition, the entry of persons into wage earning activities may be affected by their expected morbidity. Although there is no a priori reason to assume healthier labor is more productive in a wage job than in family or self employment, we expect that wage workers are selectively hired, retained, and promoted by employers, if the workers have accumulated larger stocks of health capital, i.e. exhibit lower expected morbidity, just as employers are likely to hire wage workers who have more educational attainment, other things equal.[9] Evidence of a sorting pattern of workers according to health into wage work has not been examined in low income countries. The hypothesis is tested here by substituting predicted morbidity from equation (9) into the sample selection probit equation (10), and to achieve identification, the community health input prices, P, are then excluded from the probit equation.

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[8]Suppose the wage and hours functions are represented as simple semi-logarithmic equations:

$$W = b_0 + b_1E + b_2h + e_1,$$

$$L = a_0 + a_1\ln W + a_2V + a_3h + e_2,$$

then if $a_2 = 0$, the effect of health on wages, labor supply, and earnings can be written as follows:

$$d\,W/dh = b_2,$$

$$d\,L/dh = a_1 b_2 + a_3, \text{ and}$$

$$d\,Y/dh = (1 + a_1)b_2 + a_3.$$

If however, $a_2 < 0$, as we expect if time not working for wages is a normal good whose demand increases with wealth, V, then the income uncompensated wage effect, a_1, represented above, is algebraically smaller (i.e. less positive or more negative) than the appropriate income-compensated wage effect. In this case, these approximations of labor supply and earnings effects of health are downward biased measures of the potential productivity gains due to expected health improvements.

[9]This could occur if the skills and training for workers in wage employment were more specific to their jobs than in the case of workers in family or self employment. Wage workers would then be less readily substituted for each other without sacrificing output in firms than would workers in family enterprises. Firms would then have an added incentive to hire persons who are less likely to be unable to work because of illness, over and above the incentives that families also confront to employ healthy workers and thus to raise the health stock of their own family members. If this hypothesis is correct, there should be an increased motivation to invest in health capital as the workforce acquires more specific training and the share of wage and salary workers in the economy increases.

4. Morbidity in Côte d'Ivoire and Ghana

West African Health Conditions

Morrow (1984) estimated for Ghana the incidence and duration of diseases and other health problems in the early 1980s. These are summarized in Table 1. Although the level of these estimates of healthy days lost per person per year may be debatable, they appear to represent a reasonable ranking of the morbidity problems in Ghana, given the limited aggregate indicators of health in the region. The prominence of childhood infectious and parasitic diseases reflects in part the youthful age composition of Ghana, and conversely the low weight given to degenerative diseases such as cancer and cardiovascular diseases, because the elderly constitute a correspondingly small proportion of this high fertility population.

Malaria, pneumonia and bronchitis are major, readily identifiable, causes of death as well as morbidity, and tuberculosis claims about half to a quarter as many lives as does malaria or pneumonia, according to another set of estimates of cause-specific death rates for Ghana (Patterson, 1981). Cause-specific death rates for childhood diseases are not estimated reliably at the national level, but undoubtedly include malaria, measles, diarrhea, tetanus and pertussis.[10]

In Côte d'Ivoire still fewer estimates are available ranking diseases and health conditions as a cause of death, illness or disability. Measles, diarrhea, pneumonia, malaria, tetanus, pertussis and meningitis are reported in this order as the most frequent causes of death in the first month of life in the Boundiali region of Côte d'Ivoire in 1981-82 (Sokal, et al., 1988). Doctors and individuals are required to register certain illnesses in Côte d'Ivoire, and in 1980 the most frequent of these registered diseases was treponematoses (a spirochete), followed by measles, onchocerciasis, schistosomiasis, leprosy, and tuberculosis, whereas malaria, which is hyperendemic and widely regarded to be the most serious disease throughout West Africa, is not an illness for which registration is required (Remy, 1988, p. 71).

The information on major causes of adult morbidity are more limited, with much of the effort of preventive health channeled into care of children and expectant mothers, in an effort to reduce the relatively high levels of infant, childhood, and maternal mortality. Malaria is not only a common cause of childhood mortality, but also of pregnancy wastage and adult morbidity, as it manifests itself in

[10]They have been assessed with more precision in limited study areas, such as in the Danfa project (Newmann et al., 1991). Analysis of health surveys also suggest that measles remains a major source of child mortality, and one that child immunization programs can reduce substantially, even in a malnourished population (Clemens, et., 1988).

Table 1

Disease Problems in Ghana, 1981:
Ranked According to Healthy Life Lost

Disease or Health Condition	Days of Healthy Life Lost Per 1,000 Persons Per Year
Malaria	32,600
Measles	23,400
Pneumonia (children)	18,600
Sickle cell disease	17,500
Malnutrition (severe)	17,500
Prematurity at birth	16,800
Birth injury	16,400
Accidents	14,500
Gastroenteritis	14,500
Tuberculosis	11,000
Cerebrovascular Pneumonia (adults)	9,100
Other Vector and Soil Transmitted Diseases	
Schistosomiasis	4,368
Onchocerciasis	1,926
Hookworm	1,482
Ascaris	1,222
Trypanosomiasis	195
Guinea worm	108

Source: R. H. Morrow, Jr. (1984).

recurring disabling bouts of high fever. Studies have attempted to estimate the effects of malaria on adult labor productivity in Central and South America and Africa, but there remains considerable uncertainty as to the consequences of malaria eradication or control on adult productivity in West Africa, or for that matter any proven strategy for achieving such an eradication (Morrow, et al., 1982; AAAS, 1991).

Prevalence of Morbidity in Côte d'Ivoire and Ghana

Information is first summarized on morbidity and disability in Ghana and Côte d'Ivoire as collected in parallel Living Standard Measurement Surveys (LSMS) during the late 1980s. Adult wage productivity and labor supply are analyzed in the next section conditional on morbidity, which is treated as an outcome of past home and community health inputs. A sample selection correction procedure is adopted because the final analysis is restricted to wage earners in the population. A Tobit model is then used to explain days disabled, and tests for the exogeneity of disability are reported before reestimating the effect of disability on worker productivity.

Combining the three years of the LSMS from Côte d'Ivoire for 1985 to 1987, we obtain a sample of about 40,000 persons (Ainsworth and Munoz, 1986). Responses to the morbidity questions are tabulated in the upper half of Table 2, by sex and age. The percentage ill and injured falls from about a quarter in the preschool age group to a sixth for boys and girls age 5 to 14, and then rises to about one fifth for women and men 15 to 39. Among those over age 39, the proportion having been ill or injured in the last month is substantially higher, or about two-fifths. Approximately half of the days that Ivorians report ill are classified by them as sufficiently severe to preclude them from engaging in normal activities, i.e. work in the labor force, home or in school.

Combining the two years of the LSMS from Ghana for 1987-88 and 1988-89, we obtained a sample of about 30,000 persons for the tabulation in the lower half of Table 2 (Glewwe, 1987). The proportions of the Ghanaian population reporting an illness or injury in the last four weeks is somewhat higher than in Côte d'Ivoire, in all age groups. The age pattern of reported morbidity is again similar to that expected for mortality in both populations, declining from an elevated level in infancy to a low for school-aged children, rising sharply only after middle age. Individuals in Ghana report that in about two-thirds of their ill days they were unable to engage in their usual activities. Differences between men and women in reported morbidity are not salient, although in both countries the incidence of morbidity for women exceeds that for men during the childbearing years, age 15 to 39. Differences in mortality

Table 2

Percentage of Population Ill or Injured in Last Four Weeks, Days Ill and Days Unable to Work, by Sex and Age: Côte d'Ivoire and Ghana (mean for entire population in age–sex category)

	All Persons	Percent ill or injured	Number of days ill or injured	Number of days unable to engage in regular activity
	(1)	(2)	(3)	(4)
Côte d'Ivoire 1985–1987				
Men, Age:				
0–4	3266	26.8	2.50	1.54*
5–14	6209	18.1	1.55	.80
15–39	6575	17.1	1.62	.87
40 or more	3297	41.9	6.06	3.81
Women, Age:				
0–4	3190	24.5	2.19	1.33*
5–14	5959	15.8	1.21	.64
15–39	7751	21.1	2.19	1.26
40 or more	3674	38.4	6.06	3.47
Ghana 1987–1989				
Men, Age:				
0–4	2709	43.2	3.05	1.31*
5–14	4700	30.3	1.85	.78
15–39	5172	34.4	2.47	1.07
40 or more	2555	44.3	4.78	2.26
Women, Age:				
0–4	2704	42.2	2.98	1.30*
5–14	4481	27.7	1.63	.72
15–39	5827	36.4	2.55	1.14
40 or more	3008	48.1	5.36	2.24

*It is not clear how the interviewer determined whether a child less than age 5 was too ill to engage in his or her "normal" activity.

between men and women are also not a distinct feature of the few reliable life tables available for sub-Saharan African populations (United Nations, 1982).

Morbidity differentials can be compared for segments of the population that often experience different mortality rates. For this purpose, morbidity is measured more restrictively as days inactive due to illness in the last four weeks, and Tables 3 and 4 are tabulated for the population in rural and urban areas separately by age and sex. Adults are further disaggregated by education, and for only wage earners in the lower panels. As expected from mortality differentials, morbidity is generally higher in rural than in urban areas, and increases sharply for older individuals in rural areas. The differentials by education suggest a lower level of morbidity among persons with more education beyond the primary level. But there are some cases, such as males age 15 to 39 in Côte d'Ivoire, where some primary schooling is related to higher morbidity rates compared with those with no schooling in the same area. Among the higher educated, older age groups, the cells (in parentheses) for this tabulation are often small, particularly in rural areas, and the cell means are consequently highly variable. These data provide little support for the "cultural conditioning" hypothesis if it is interpreted as implying that better educated and urban populations in low income countries should report higher levels of morbidity, even though their "true" health status is superior in comparison to that of their rural, less educated, counterparts (Johansson, 1991).

If education conditions people to report themselves as more frequently ill, this subjective bias may be minimized by focusing the analysis on only wage earners, for whom reporting ill generally implies a direct penalty in terms of foregone earnings. Table 5 reports the coefficients on years of primary, middle, and secondary education in a multiple regression on the days inactive due to illness in the last four weeks for men and women in the two LSMS samples. Controls are also included in this regression (but not reported here) for the individual's age and several aspects of the local health infrastructure, local market prices, climate, and region (Cf. Table 12). For all adults age 15 to 64, there is a tendency for years of primary schooling to be associated with an increase in reported days ill and days inactive due to illness (columns 1 and 3 of Table 5). Among women in Ghana there is also a tendency for reported morbidity to decrease with years of middle school and increase again with years of secondary school.

For the more restricted sample of wage earners, however, the three education coefficients are never jointly statistically significant at the 5 percent level, and only in the case of secondary education for Ghanaian women is the education coefficient statistically significantly different from zero (one out of 24 possible coefficients in columns 2 and 4). The positive relationship between adult education and reporting

TABLE 3

Number of Days Inactive Because of Illness or Injury in Last Four Weeks, by Sex, Age, Education and Rural Urban Residence: Côte d'Ivoire 1985–88 (Number of Survey Respondents in Parentheses)

Sex, Age and Rural/Urban Residence	Educational Level				
	All Education	None	Some Primary	Some Middle	Some Secondary
All Males					
Age 0–4					
Rural	1.75 (1904)	--	--	--	--
Urban	1.24 (1362)	--	--	--	--
Age 5–14					
Rural	.91 (3530)	--	--	--	--
Urban	1.04 (2676)	--	--	--	--
Age 15–39					
Rural	1.04 (2913)	.91 (1482)	1.38 (907)	.91 (411)	.49 (78)
Urban	.73 (3658)	.52 (1037)	.94 (772)	.87 (1185)	.55 (113)
Age 40 or More					
Rural	4.44 (2084)	4.52 (1880)	3.86 (181)	2.95 (21)	1.00 (2)
Urban	2.73 (1213)	3.13 (773)	2.78 (247)	1.24 (117)	.78 (76)
All Females					
Age 0–4					
Rural	1.07 (1417)	--	--	--	--
Urban	1.54 (1770)	--	--	--	--
Age 5–14					
Rural	.70 (3073)	--	--	--	--
Urban	.59 (2885)	--	--	--	--
Age 15–39					
Rural	1.37 (3717)	1.38 (2882)	1.36 (692)	1.09 (139)	.25 (4)
Urban	1.16 (4031)	1.09 (1963)	1.31 (966)	1.10 (856)	1.24 (246)
Age 40 or More					
Rural	3.83 (2487)	3.84 (2471)	2.40 (15)	.0 (1)	--
Urban	2.74 (1185)	2.80 (1104)	1.95 (40)	1.62 (29)	2.92 (12)

Males in Wage Labor Force					
Age 15–39					
Rural	1.30	1.35	1.30	1.30	.30
	(751)	(422)	233)	(73)	(23)
Urban	.83	.82	.98	1.09	.46
	(1096)	(273)	(246)	(283)	(294)
Age 40 or More					
Rural	2.31	2.28	2.58	1.80	2.00
	(1245)	(1096)	(133)	(15)	(1)
Urban	1.39	1.55	1.40	.96	.87
	(771)	(460)	(159)	(91)	(61)
Females in Wage Labor Force					
Age 15–39					
Rural	1.55	1.47	2.11	.33	.33
	(713)	(597)	(104)	(9)	(3)
Urban	1.18	.93	1.74	1.50	.61
	(757)	(597)	(160)	(147)	(71)
Age 40 or More					
Rural	2.60	2.62	.0	--	--
	(675)	(670)	(5)		
Urban	1.80	1.87	.96	.57	3.50
	(440)	(385)	(24)	(21)	(10)

Source: Côte d'Ivoire Living Standard Survey, 1985–1987. Totals for all persons do not always add up to the totals in Table 2 because a few persons did not report their education and are excluded from the subsequent analysis.

TABLE 4

Number of Days Inactive Because of Illness or Injury in Last Four Weeks, by Sex, Age, Education and Rural Urban Residence: Ghana 1987–89 (Number of Survey Respondents in Parentheses)

Sex, Age and Rural/Urban Residence	Educational Level				
	All Education	None	Some Primary	Some Middle	Some Secondary
All Males					
Age 0–4					
Rural	1.50 (1180)	--	--	--	--
Urban	1.29 (785)	--	--	--	--
Age 5–14					
Rural	.81 (2005)	--	--	--	--
Urban	.82 (1345)	--	--	--	--
Age 15–39					
Rural	1.19 (2092)	1.07 (541)	1.55 (295)	1.17 (1066)	1.06 (190)
Urban	.90 (1696)	.70 (221)	.91 (185)	1.06 (928)	.59 (362)
Age 40 or More					
Rural	2.55 (1230)	270 (635)	2.87 (90)	2.33 (215)	1.09 (43)
Urban	1.26 (736)	1.90 (331)	2.63 (57)	1.30 (262)	.74 (111)
All Females					
Age 0–4					
Rural	1.43 (1230)	--	--	--	--
Urban	1.26 (736)	--	--	--	--
Age 5–14					
Rural	.80 (1820)	--	--	--	--
Urban	.73 (1426)	--	--	--	--
Age 15–39					
Rural	1.25 (2188)	1.06 (1034)	1.80 (351)	1.25 (751)	1.65 (52)
Urban	1.05 (1891)	.83 (551)	1.45 (257)	1.01 (861)	1.31 (222)
Age 40 or More					
Rural	2.32 (1191)	2.34 (1052)	2.25 (67)	1.77 (66)	5.67 (6)
Urban	1.81 (772)	1.90 (555)	1.38 (53)	1.55 (130)	1.91 (34)

Males in Wage Labor Force					
Age 15–39					
Rural	1.40	1.28	1.54	1.42	1.39
	(1077)	(273)	(151)	(568)	(85)
Urban	.95	.94	1.10	1.13	.32
	(809)	(83)	(73)	(493)	(160)
Age 40 or More					
Rural	1.78	1.92	1.60	1.85	.50
	(571)	(319)	(56)	(159)	(36)
Urban	.95	1.23	1.27	.74	.62
	(488)	(183)	(44)	(182)	(79)
Females in Wage Labor Force					
Age 15–39					
Rural	1.40	1.46	1.61	1.21	2.08
	(802)	(346)	(144)	(300)	(12)
Urban	1.13	1.13	1.57	1.05	.88
	(778)	(195)	(115)	(373)	(95)
Age 40 or More					
Rural	1.70	1.67	1.25	1.87	5.67
	(514)	(427)	(36)	(45)	(6)
Urban	1.60	1.65	1.38	1.47	1.92
	(336)	(212)	(32)	(68)	(24)

Source: Ghana Living Standard Survey, 1987–1989 (the first year and one half). Totals do not add up to those in Table 2 because these figures reflect only the first year and one half of the survey and exclude persons not reporting their education.

Table 5

Regression Coefficients on Years of Schooling in Reduced-Form Equations for Number of Days Ill and Inactive in Last Four Weeks

Country and Variable	Men				Women			
	Days Ill		Days Inactive		Days Ill		Days Inactive	
	All (1)	Wage earners (2)	All (3)	Wage earners (4)	All (1)	Wage earners (2)	All (3)	Wage earners (4)
Côte d'Ivoire								
Years of Schooling (maximum in years):								
Primary (6)	.230 (6.43)	.017 (.20)	.130 (4.83)	−.003 (.06)	.301 (6.73)	.211 (.91)	.146 (4.44)	.111 (.67)
Middle (4)	.048 (.76)	.210 (1.74)	−.052 (1.09)	−.002 (.02)	.083 (.87)	−.186 (.66)	.063 (.89)	−.054 (.27)
Secondary or More (3+)	.052 (.80)	−.001 (.01)	−.045 (.91)	−.061 (1.12)	−.012 (.09)	−.072 (.38)	−.065 (.69)	−.203 (1.49)
Sample Size	7832	1452	7832	1452	9099	376	9099	376
Ghana								
Years of Schooling (maximum in years):								
Primary (6)	.157 (3.05)	.098 (.74)	.033 (1.03)	−.080 (1.20)	.234 (5.15)	−.154 (.70)	.094 (3.31)	−.023 (.17)
Middle (4)	−.030 (.45)	−.131 (.80)	.007 (.18)	.043 (.52)	−.125 (1.82)	.195 (.74)	−.085 (1.98)	−.037 (.23)
Secondary or More (3+)	.032 (.78)	.024 (.41)	−.014 (.57)	−.017 (.58)	.228 (3.86)	.163 (1.77)	.108 (2.92)	.104 (1.90)
Sample Size	5605	1471	5605	1471	6067	454	6067	454

illness and inactivity due to illness is thus eliminated by restricting our analysis to wage earners. There may, of course, still be a subjective reporting bias in the morbidity data even for wage earners. For example, the estimated relationship (i.e. zero) may understate a "true" gain in health associated with education, but these figures certainly suggest that by restricting the analysis to wage earners, for whom the activity question conveys a clear cost threshold, the problem of measuring morbidity through self response is reduced if not eliminated (see Sindelar and Thomas, 1991, for a related discussion).

Table 6 reports, however, that the share of the total sample (I) of adults who works primarily for wages is relatively small in these two populations. Only 4.1 percent of the women in Côte d'Ivoire and 7.5 percent in Ghana work in their primary job as a wage earner, whereas for men about one in four or five work as wage earners. Any analysis of the effect of morbidity on wage productivity for West African women must rely on a relatively small, and potentially unrepresentative sample.

The community questionnaire employed in these LSMS surveys asks a few simple questions about the time required to reach a number of medical care providers, such as doctors, clinics and hospitals. These are regrettably crude measures of access and price of health services, and they tend to be highly correlated, reducing their value as multiple predictors of health status. To incorporate more extensive information on the quality, diversity and price of medical services in the local community, the LSMS respondents may be linked to another survey of health facilities, conducted in Côte d'Ivoire in 1988 and in Ghana in 1989. Restricting the original sample (I) to persons living in communities for which the nearest health facility can be monitored through the health facility survey, the size of the matched facility sample (II) in Table 6 is reduced by a third in Côte d'Ivoire and by almost three-fifths in Ghana. Because, the information from the health survey helps to explain the incidence of morbidity, the model to appraise the effect of morbidity on wages and earnings is reestimated for this smaller sample (II) for which information on health facilities is improved. A clear trade off emerges; about half the sample size is sacrificed to increase by about one-third the proportion of the variation in morbidity explained by the vector of instrumental variables.

5. Estimation of the Effects of Health in the Wage Functions

The means and standard deviations of selected variables for both the samples of all persons age 15 to 65 and those who are primarily wage earners in the pooled 1985, 1986, and 1987 Côte d'Ivoire LSMS, and the pooled 1987-88, 1988-89 Ghana LSMS are reported in Appendix Tables A-1 and A-2. Males constitute more than three-fourths of the wage earners in Côte d'Ivoire and Ghana, but women in both

Table 6

Sample Sizes for Analysis of Morbidity and Adult Productivity

Sample Restriction	Côte d'Ivoire 1985–1987		Ghana 1987–1989	
	Male	Female	Male	Female
I.a. All Persons Age 15 to 64	7832	9099	5605	6067
b. and Reporting wages	1452	376	1471	454
b/a. Wage Participation Rate	.185	.041	.263	.075
II.a. Living in Communities where health facility survey also available	4959	5655	2414	2476
b. and Reporting Wages	989	263	695	192
b/a. Wage Participation Rate	.199	.047	.288	078

countries frequently participate in the labor force in the capacity of self employed or family workers. Women receive substantially less education than men on average, but better educated women are much more likely to be wage earners. As a consequence, women wage earners report higher education than male wage earners. In both countries wage earners are disproportionately concentrated in urban areas. The majority of wage earners in Côte d'Ivoire reside in the capital, Abidjan, while only about a third in Ghana live in Accra. Most of the rural population who are small scale farmers or engaged in trade are regrettably not represented in the final estimation sample of wage earners.

Regions of both countries have different climates, infrastructural development and disease problems. Including regional dummy variables in wage and earnings regressions is likely to understate the coefficient on education, to the extent that a major part of the market returns to education accrue to persons educated in the poorer regions of low income countries, because schooling facilitates their outmigration to higher wage regions (Schultz, 1988). To obtain lower bound estimates of health effects on labor productivity, regional and urban/rural variables are included in all wage, hours, and earnings equations.

Wages are first deflated to adjust for regional differences in price levels, and in particular for the higher cost of living in Abidjan and a slightly higher price level in Accra than elsewhere in Ghana. Then, since the surveys are collected over two to three years, the wages reported by the respondent are further adjusted for the national real purchasing power price level during the month of the survey. Wages correspond to the prices prevailing in the first month of the Ghana survey, i.e. September 1987 (Glewwe, 1987), and to the average prices for all of 1985 in Côte d'Ivoire (Ainsworth and Munoz, 1986). A monthly price index was not found for Côte d'Ivoire, but since the rate of inflation was less than 10 percent per year from 1984 to 1988, it was simply assumed that the annual rate of inflation was uniformly distributed over the twelve months from June of one year to July of the next.

Tables 7, 8, 9 and 10 present the maximum likelihood estimates of the wage, hours, and earnings equations, each estimated jointly in semi-logarithmic form with the probit model for selection into the sample of wage earners (Heckman, 1979; Greene, 1981). The number of inactive sick days in the last four weeks, our measure of adult morbidity, may be endogenous and measured with error. It is therefore estimated by instrumental variables, where all the variables in the wage earner selection equation (food prices, and various indicators of the local health and transportation infrastructure problems of the community) are treated as instruments. According to the Hausman (1978) specification test, the residual from the predicted morbidity variable is included with the actual variable in the wage

Table 7

Male Wage, Hours and Earnings Equations Jointly Estimated by Maximum Likelihood with Wage Earner Sample Selection Equation: Côte d'Ivoire, Large Sample with Community Questionnaires

Explanatory Variables	(1) Wage Earner	(1) Log Wage	(2) Wage Earner	(2) Log Hours	(3) Wage Earner	(3) Log Earnings
Predicted Days Sick and Unable to Work at Wage Job	−.242 (3.47)	−.187 (4.07)	−.248 (3.54)	−.105 (3.41)	−.242 (3.52)	−.290 (6.36)
Years of Schooling Completed:						
Primary	.137 (13.1)	.119 (7.29)	.137 (13.2)	.00625 (.41)	.137 (13.2)	.123 (6.88)
Middle	.186 (10.5)	.247 (10.6)	.184 (10.4)	.0150 (.62)	.185 (10.5)	.258 (9.65)
Secondary or More	.184 (10.1)	.189 (10.9)	.179 (9.70)	−.0234 (1.51)	.184 (10.1)	.163 (7.86)
Postschooling Experience (in years)	.188 (27.5)	.0631 (3.91)	.186 (27.6)	.0297 (1.80)	.188 (27.8)	.0890 (5.27)
Experience Squared ($\times 10^{-2}$)	−.284 (20.7)	−.0292 (1.05)	−.281 (20.8)	−.0344 (1.25)	−.284 (20.9)	−.0576 (2.05)
Distance to Nearest Permanent Market (km)	−.0239 (2.66)		−.0237 (2.50)		−.0264 (2.82)	
Region (Abidjan Excluded):						
Other Urban	−.159 (1.59)	.181 (3.43)	−.159 (1.59)	.0718 (1.51)	−.156 (1.57)	.112 (1.99)
Forest East	−.972 (9.20)	.239 (1.94)	−.976 (7.40)	−.346 (2.82)	−.951 (7.29)	−.0837 (.61)
Forest West	−1.39 (9.20)	.527 (2.98)	−1.39 (9.09)	−.425 (2.05)	−1.36 (8.85)	.140 (.72)
Savanna−North	−1.16 (7.90)	.286 (1.30)	−1.17 (7.91)	−.243 (1.40)	−1.13 (7.67)	.0717 (.35)
Business Assets ($\times 10^{-8}$)	.059 (.24)		.100 (.39)		.101 (.43)	
Value of Land ($\times 10^{-8}$)	−.546 (3.19)		−.571 (3.21)		−.541 (3.33)	
Saving Assets ($\times 10^{-8}$)	−.569 (.90)		−1.10 (1.18)		−1.05 (1.38)	
Unearned Income ($\times 10^{-8}$)	−19.4 (4.89)		−20.5 (5.07)		−19.0 (4.90)	
Tontines ($\times 10^{-8}$)	16.9 (.31)		.488 (.01)		11.8 (.21)	
Dowry ($\times 10^{-8}$)	−2.30 (1.50)		−2.06 (1.35)		−2.33 (1.55)	
Intercept	−2.73 (8.60)	3.95 (10.6)	−2.70 (8.46)	7.22 (19.0)	−2.69 (8.60)	11.3 (27.7)
Sigma/Rho	.869 (35.3)	−.274 (2.01)	.720 (73.5)	−.0535 (.30)	95.3 (31.8)	−.326 (2.39)

Table 8

Male Wage, Hours and Earnings Equations Jointly Estimated by Maximum Likelihood with Wage Earner Sample Selection Equation: Ghana, Large Sample with Community Questionnaires

Explanatory Variables	(1)		(2)		(3)	
	Wage Earner	Log Wage	Wage Earner	Log Hours	Wage Earner	Log Earnings
Predicted Days Sick and Unable to Work at Wage Job	−.163 (2.76)	−.0130 (.26)	−.0887 (1.81)	−.105 (2.05)	−.158 (2.70)	−.0437 (.77)
Years of Schooling Completed:						
Primary	.00388 (.24)	−.0137 (.80)	.00720 (.49)	.0432 (2.26)	.0050 (.31)	.0672 (3.28)
Middle	.152 (7.68)	.0848 (3.20)	.116 (6.44)	−.0948 (4.01)	.151 (7.62)	.168 (6.31)
Secondary or More	.104 (10.2)	.125 (10.9)	.0735 (7.31)	−.0977 (7.54)	.104 (10.2)	.104 (7.09)
Postschooling Experience (in years)	.0878 (17.8)	.0630 (7.41)	.0688 (14.5)	−0507 (8.30)	.0877 (17.9)	.0933 (9.86)
Experience Squared ($\times 10^{-2}$)	−.135 (14.5)	−.0964 (6.55)	−.108 (12.1)	−.0913 (7.86)	−.135 (14.5)	−.129 (7.47)
Distance to Nearest Permanent Market (km)	−.0133 (3.02)		−.00898 (3.46)		−.0132 (3.01)	
Region (Accra Excluded):						
Coast Urban	−.311 (.03)	.113 (1.64)	−.0269 (.33)	−.131 (1.53)	−.484 (.05)	−.132 (1.73)
Coast Rural	−.661 (4.90)	.103 (.81)	−.657 (5.73)	−.588 (5.16)	−.654 (4.81)	−.118 (.83)
Forest Urban	−.201 (1.61)	.0679 (.93)	−.365 (3.69)	−.255 (3.21)	−.203 (1.60)	−.0260 (.30)
Forest Rural	−.294 (1.72)	−.0366 (.31)	−.568 (4.33)	−.744 (6.80)	−.308 (1.80)	−.185 (1.36)
Savannah Urban	−.437 (3.37)	−.0484 (.53)	−.450 (4.02)	.354 (3.31)	−.426 (3.27)	−.0659 (.54)
Savannah Rural	−1.23 (8.63)	−.105 (.60)	−1.25 (10.6)	1.27 (10.5)	−1.22 (8.47)	.0250 (.13)
Business Assets ($\times 10^{-6}$)	−2.34 (8.80)		−.872 (5.55)		−2.34 (8.84)	
Value of Land ($\times 10^{-6}$)	−.139 (5.43)		−5.05 (3.46)		−.137 (5.44)	
Saving Assets ($\times 10^{-6}$)	−1.13 (3.03)		−.300 (1.51)		−1.04 (2.78)	
Unearned Income ($\times 10^{-6}$)	.00343 (.00)		.555 (.71)		.110 (.10)	
Susu ($\times 10^{-6}$)	3.94 (1.90)		3.29 (1.97)		4.21 (2.03)	
Dowry ($\times 10^{-6}$)	−.195 (.92)		.0228 (.25)		−.205 (.93)	
Intercept	−4.07 (6.60)	2.50 (11.6)	−2.85 (6.24)	9.48 (69.3)	−4.07 (6.55)	9.70 (39.4)
Sigma/Rho	.800 (49.2)	.164 (1.19)	1.31 (59.9)	−.977 (234.)	.961 (64.8)	−.574 (.44)
Sample Size	5605	1471	5605	1471	5605	1471

Table 9

Female Wage, Hours and Earnings Equations Jointly Estimated by Maximum Likelihood with Wage Earner Sample Selection Equation: Côte d'Ivoire and Ghana, Large Samples

Selected Explanatory Variables	(1) Wage Earner	(1) Log Wage	(2) Wage Earner	(2) Log Hours	(3) Wage Earner	(3) Log Earnings
Côte d'Ivoire, Women						
Predicted Days Sick and Unable to Work	−.0174 (.43)	−.0517 (1.37)	−.0145 (.57)	−.0413 (.85)	−.0182 (.43)	−.0949 (2.32)
Years of Schooling Completed:						
Primary	.213 (12.3)	−.0904 (1.91)	.213 (12.6)	.0330 (.55)	.212 (11.9)	.129 (2.34)
Middle	.272 (9.77)	.208 (3.29)	.273 (9.72)	−.0464 (.62)	.273 (9.72)	.261 (3.39)
Secondary or More	.208 (6.44)	.187 (4.94)	.207 (6.42)	−.0889 (1.90)	.208 (6.35)	.102 (2.50)
Sigma/Rho	.840 (20.6)	−.202 (.73)	−.780 (25.2)	−.100 (.25)	.857 (13.4)	−.249 (.78)
Ghana, Women						
Predicted Days Sick and Unable to Work	.0460 (.92)	.0363 (.81)	.0477 (.95)	.0152 (.22)	.0469 (.93)	.0510 (.77)
Years of Schooling Completed:						
Primary	.0571 (2.79)	−.0098 (.28)	.0567 (2.81)	.0317 (.79)	.0568 (2.84)	.0210 (.45)
Middle	.143 (5.55)	.149 (3.11)	.143 (5.50)	.0222 (.34)	.143 (5.49)	.169 (2.21)
Secondary or More	.195 (10.9)	.103 (2.47)	.194 (10.9)	−.122 (.22)	.195 (10.9)	.0890 (1.33)
Sigma/Rho	.750 (36.7)	.0143 (.04)	.961 (14.6)	−.191 (.47)	1.07 (14.7)	−.177 (.42)

Table 10

Male Wage, Hours and Earnings Equations Jointly Estimated by Maximum Likelihood with Wage Earner Sample Selection Equation: Côte d'Ivoire and Ghana, Large Samples

Selected Explanatory Variables	(1) Wage Earner	(1) Log Wage	(2) Wage Earner	(2) Log Hours	(3) Wage Earner	(3) Log Earnings
Côte d'Ivoire, Men						
Predicted Days Sick and Unable to Work	−.165 (3.36)	−.0693 (1.67)	−.164 (3.45)	−.0535 (2.11)	−.176 (3.74)	−.122 (3.06)
Years of Schooling Completed:						
Primary	.138 (9.48)	.108 (5.98)	.140 (9.69)	−.0214 (1.41)	.136 (9.44)	.0830 (4.38)
Middle	.197 (8.49)	.245 (9.68)	.193 (8.27)	.0053 (.25)	.195 (8.48)	.247 (9.53)
Secondary or More	.199 (9.70)	.198 (11.4)	.193 (9.20)	−.0364 (2.74)	.198 (9.63)	.160 (7.41)
Sigma/Rho	.877 (33.6)	−.348 (3.27)	.670 (46.8)	−.203 (1.51)	.939 (28.8)	−.503 (5.62)
Sample Size	4959	989	4959	989	4959	989
Ghana, Men						
Predicted Days Sick and Unable to Work	.0460 (.92)	.0363 (.81)	.0477 (.95)	.0152 (.22)	.0469 (.93)	.0510 (.77)
Years of Schooling Completed:						
Primary	.0571 (2.79)	−.0098 (.28)	.0567 (2.81)	.0317 (.79)	.0568 (2.84)	.0210 (.45)
Middle	.143 (5.55)	.149 (3.11)	.143 (5.50)	.0222 (.34)	.143 (5.49)	.169 (2.21)
Secondary or More	.195 (10.9)	.103 (2.47)	.194 (10.9)	−.122 (.22)	.195 (10.9)	.0890 (1.33)
Sigma/Rho	.750 (36.7)	.0143 (.04)	.961 (14.6)	−.191 (.47)	1.07 (14.7)	−.177 (.42)

function to assess whether morbidity is exogenous. Conditional on identification by the specified instrumental variables, the exogeneity of morbidity is rejected for both the Ivorian and Ghanaian samples of male wage earners at the significance level of 5 percent, as indicated by the t-statistic for the residual. However, exogenity of the morbidity variable in the much smaller samples of women wage earners from the two countries is not rejected at the 5 percent significance level.

Table 7 reports for men in Côte d'Ivoire all the estimates except the price and rainfall coefficients in the selection equation. The first coefficient in the wage equation indicates that an individual who is predicted to have one day ill and inactive in the last month is expected to receive a wage rate that is 18.7 percent lower than an individual who is not disabled by illness in the last month. This is based on the full sample of 1,452 male wage earners in Côte d'Ivoire. Annual hours of work is reduced by 10.5 percent by this level of morbidity, and annual earnings are depressed by 29 percent. We have noted that for full-time workers, for whom the income effect is probably negative, the hours effect (and hence the earnings effect) of health is probably a downward biased indicator of the potential economic gain from a reduction in morbidity. In this, our largest sample, the productivity effects of morbidity are large and defined relatively precisely, with the asymptotic t ratios on the morbidity coefficients being highly significant, 4.0, 3.4 and 6.4, respectively, in the wage, hours, and earnings equations.

Table 8 indicates smaller and less statistically significant effects of morbidity on male wage productivity in Ghana. Hours are reduced by the same amount as in Côte d'Ivoire, 10.5 percent per day ill and inactive, but the wage effect is not statistically significant and the point estimate is only 1.3 percent.

For women, Table 9 summarizes only the morbidity and education coefficients. Although the female wage differentials associated with years of education (i.e. private returns) are similar to those for males, the estimated effects of instrumented morbidity are only one third as large for women as for men in Côte d'Ivoire; wages 5.2 percent lower, hours 4.1 percent, and earnings 9.5 percent for each predicted day of inactivity due to illness. In Ghana the health effects are insignificant and of the opposite sign. Either the measurement of morbidity, or the effect of morbidity on productivity, is different for women than for men, or the much smaller size of the female wage samples simply does not permit any inferences.

In industrially advanced countries where health surveys and vital registration systems appear adequate, sex differences in self reported and medically evaluated morbidity associated with <u>chronic</u> diseases appear similar to sex differences in mortality by these respective causes, e.g. female morbidity is generally lower than male. However, women often report higher rates of morbidity than do men for acute health conditions, doctor visits, overall health status, and days of restricted activity due to illness (Waldron, 1983, Waldron, et al., 1982; Verbrugge, 1985). There are many cultural as well as biological and economic explanations for sex differences in mortality and morbidity. There does not appear to be a consensus on which explanations account for these complex patterns in mortality and morbidity between men and women in developed countries, and if anything, a wider range of hypotheses should be considered in the study of gender differences in health status in low-income countries.

Table 10 reports the core coefficients again for men for sample II in which health facility survey information can be added to the list of instruments to predict inactive days due to illness. Recall that these estimates are obtained from samples that are about half as large as those reported earlier. The effects of morbidity are no longer statistically significant in Ghana, and the magnitude of the effects for males in Côte d'Ivoire decreases by about half, to a 6.9 percent reduction in wages, 5.4 percent in hours, and 12.2 percent in earnings per day ill and inactive.

Tobit Model Alternative for Morbidity Equation

Because the measure of morbidity is constrained to be non-negative, and the majority of adults in all samples report zero days disabled in the reference period, ordinary least squares estimates of the morbidity equation are potentially biased. A left censored Tobit model is therefore specified for the morbidity equation, assuming that the error about the latent index function is normally distributed. This specification is analogous to the model developed in Section 3, except that it explicitly deals with the concentration of persons at (the point of) zero days disabled and assumes that the number of days disabled captures variation in health status that affects worker productivity. The expected value locus of days disabled in the tobit framework is a nonlinear function of the latent (linear) index function, due to the process assumed to censor the observations. There is little indication from the prior analysis reported in Tables 7-10 that sample selection is a serious source of parameter bias in the estimation of wage functions for only wage earners; most values of rho estimated are not statistically different from zero. The estimation of the Tobit model of morbidity and wage (or hours, or earnings) functions is therefore not corrected for sample selection bias and all instruments are employed in the Tobit first stage to predict morbidity.

The Tobit estimates of the morbidity equation are reported in Table 11 for the full sample (I) of wage earners. As expected, most coefficient estimates are larger than the corresponding ordinary least squares estimates which are biased towards zero. Hausman (1978) type exogeneity tests are carried out

Table 11

Tobit Estimates of Number of Days Ill and Inactive in the Last Four Weeks

Explanatory Variables	Côte d'Iviore		Ghana	
	Men	Women	Men	Women
Years of Schooling:				
Primary	.179 (.62)	.276 (.40)	−.187 (.77)	.366 (.98)
Middle	−.0275 (.06)	−.0030 (.00)	.213 (.71)	−.450 (1.04)
Secondary or more	−.597 (1.66)	−.964 (1.60)	−.194 (1.70)	.248 (1.59)
Post−schooling Experience	−.0386 (.20)	−.742 (1.59)	.0822 (1.14)	.0511 (.45)
Experience Squared ($\times 10^2$)	.354 (.96)	1.77 (1.67)	−.116 (.80)	−.003 (.01)
Household Assets ($\times 10^6$)				
Business	.0822 (1.57)	−23.1 (1.23)	−4.05 (.53)	−14.3 (1.41)
Value Land	.0421 (.69)	.0362 (.53)	.0813 (.17)	−1.94 (.88)
Savings	−.482 (.82)	1.66 (1.93)	−8.65 (1.13)	25.2 (2.93)
Unearned Income	1.61 (1.74)	1.05 (1.01)	20.0 (1.83)	−1.37 (1.60)
Tontines/Susu	−27.9 (1.39)	−4.05 (.25)	19.9 (.69)	3.41 (.09)
Dowry	−2.27 (.75)	−.182 (.68)	−6.28 (.72)	1.68 (.44)
Community Cluster:				
Distance to Market (km)	.268 (.69)	−3.24 (1.00)	−.142 (1.61)	.0836 (.52)
Distance to Dr./Nurse (km)	.0425 (.27)	.369 (.52)	.0776 (.87)	.228 (1.40)
Rainfall (mm/yr)	−.0272 (.50)	−.174 (1.10)	−.0206 (.51)	−.103 (1.55)

Table 11 (continued)

Explanatory Variables	Côte d'Iviore		Ghana	
	Men	Women	Men	Women
Region:				
Forest E/Coast Rural	.272 (.06)	8.58 (.46)	2.02 (.84)	4.01 (1.09)
Forest W/Forest Rural	−1.65 (.25)	−1.05 (.04)	4.56 (1.93)	1.07 (.26)
Savanna Rural	−8.89 (1.33)	–	.855 (.28)	.0045 (.00)
Other Urban/Coast Urban	2.64 (.89)	−3.50 (.42)	2.94 (1.91)	2.41 (2.33)
Other Urban/Forest Urban	–	–	1.60 (.82)	2.23 (.68)
Other Urban/Savanah Urban	–	–	2.13 (.95)	.0861 (.02)
Prices:				
Beef/Eggs	−8.39 (.85)	2.79 (.10)	.0479 (.38)	.0857 (.48)
Fish	1.32 (.23)	−10.1 (.73)	−.00046 (.12)	.0016 (.26)
Rice/Maize	1.99 (.65)	6.52 (.92)	.0525 (1.09)	−.107 (1.50)
Onions	−5.00 (.68)	18.5 (1.11)	−.0025 (.85)	.0096 (1.90)
Peanut Butter	11.4 (2.03)	12.11 (.67)	−.00066 (.04)	.0133 (.46)
Palm Oil	−1.13 (.67)	−.42 (.08)	.0172 (1.71)	.0036 (.24)
Manioc/Cassava	.529 (.03)	29.4 (.83)	.0627 (.73)	.253 (1.83)
Bananas	−36.3 (2.09)	−60.2 (1.66)	.0112 (.40)	−.0749 (1.52)
Tomatoes	–	–	−.0008 (.11)	−.0151 (1.34)
Sugar	–	–	−.0489 (1.94)	−.0045 (.12)
Antibiotic	–	–	1.79 (2.77)	−1.21 (1.13)

Table 11 (continued)

Explanatory Variables	Côte d'Iviore		Ghana	
	Men	Women	Men	Women
Province Public Expenditures Per Capita:				
Preventive Health	–	–	.015 (.40)	.0857 (1.29)
Curative Health	–	–	.017 (1.57)	−.0196 (.99)
Community Health Problems:				
Malaria	7.85 (1.09)	36.5 (.01)	2.33 (1.56)	.915 (.32)
Diahrrea	−3.82 (.55)	−41.0 (.01)	.740 (.64)	3.88 (1.74)
Measles and Chicken Pox	.324 (.06)	−26.1 (1.45)	−.949 (.73)	−2.38 (1.25)
Water−Sanitary/Water Transport.	2.79 (.53)	−5.22 (.29)	.317 (.26)	1.41 (.78)
Malaria Eradication Campaign in last 5 years	–	–	−1.70 (1.34)	−.0667 (.04)
Immunization Campaign in last 5 years	–	–	.833 (.51)	−1.66 (.54)
Constant	7.61 (.87)	7.28 (.32)	−14.8 (1.60)	4.55 (.28)
Sigma	13.80 (17.6)	14.3 (10.5)	8.01 (22.8)	6.97 (14.3)
Log Likelihood	−1252.2	−405.5	−1659.7	−579.1
Sample Size	1452	376	1471	454
Mean of Dependent Variable (SD)	1.10 (3.70)	1.63 (4.96)	1.08 (2.96)	1.24 (3.15)

using the Tobit residuals obtained from the prediction of the observed morbidity. In the wage, hours and earnings equations expanded with the Tobit residuals, a coefficient on the Tobit residual that is significantly different from zero implies we would reject the null hypothesis of exogeneity of morbidity. The results of this testing procedure are summarized in Table 12. In the case of males from Côte d'Ivoire there is evidence for rejecting exogeneity of morbidity in the wage, hours and earnings equations at the 5 percent level of significance. The exogeneity of morbidity is not rejected in the wage, hours and earnings equations for women in Côte d'Ivoire. In the Ghanaian sample, exogeneity is rejected in the hours and earnings equations for males but not in the wage equation. For Ghanaian females the exogeneity of morbidity is rejected only in the earnings equations.

Consistent estimates of the wage, hours and earnings equations are obtained as instrumental variable estimators using the prediction of the expected morbidity variable from the Tobit estimates of the morbidity equation in place of the actual morbidity variable. These results are summarized in Table 13. The coefficient of the predicted morbidity variable is significantly different from zero only in those equations where the exogeneity of the observed morbidity is rejected by the tests shown at Table 12. The effect of an expected day of disabling morbidity in the last four weeks is to reduce male wage rates by 15 percent and lower their earnings by 29 percent in Côte d'Ivoire, as shown in Table 13. For women in Côte d'Ivoire earnings are 6 percent lower per day of disability, whereas for men in Ghana the reduction in earnings is 10 percent, and the reduction in hours worked is 12 percent per day of disability. Estimated effects of morbidity are thus quite similar regardless of whether sample selection bias is corrected within the linear model or whether the Tobit specification of morbidity replaces the linear regressions model.

6. Conclusions

The expectation of life at birth is lower in Africa than on any other continent, and it may be assumed that the burden of disabling acute and chronic health conditions is also today as heavy in Africa as it is anywhere. Although Côte d'Ivoire and Ghana have lower estimated age-specific mortality than the average country in sub-Saharan Africa, the expectation of life is still only about 53 to 55 years (World Bank, 1991).

This study has proposed an empirical approach for evaluating the disabling burden of poor health as it reduces the productivity of labor per hour worked, and possibly erodes the capacity of workers to labor longer hours. Two measurement issues have been emphasized. The first is that health may affect the

Table 12
Exogeneity Tests for Disabled Days Inactive

Selected Explanatory Variables[a]	Men Log Wage	Men Log Hours	Men Log Earnings	Women Log Wage	Women Log Hours	Women Log Earnings
Côte d'Ivoire						
Disabled Days	−.149 (2.99)	−.144 (3.44)	−.293 (5.42)	−.160 (.49)	−.043 (1.41)	−.059 (1.78)
Years of Schooling: Primary	.145 (11.79)	.015 (1.42)	.160 (11.96)	.111 (4.12)	.044 (1.74)	.154 (5.68)
Middle	.271 (15.14)	.017 (1.1)	.288 (14.81)	.244 (7.43)	−.064 (2.10)	.307 (9.30)
Secondary or More	.214 (16.66)	−.022 (2.01)	.192 (13.80)	.220 (9.26)	−.078 (3.54)	.142 (5.92)
Experience	.091 (11.32)	.034 (4.96)	.125 (14.28)	.052 (2.64)	.023 (1.25)	.748 (3.77)
Experience Square ($x10^{-2}$)	−.079 (4.84)	−.040 (2.90)	−.118 (6.71)	−.041 (.92)	−.019 (.46)	−.060 (1.33)
Residual Disabled Day (Tobit)	.147 (2.92)	.133 (3.15)	.279 (5.13)	.011 (.32)	.260 (.81)	.037 (1.06)
Ghana						
Disabled Days	.018 (.42)	−.117 (2.52)	−.098 (1.86)	.046 (1.20)	.068 (1.39)	.114 (2.11)
Years of Schooling: Primary	−.013 (.69)	−.054 (2.85)	−.067 (3.07)	−.015 (.47)	.034 (.88)	.020 (.46)
Middle	.069 (3.09)	.108 (4.56)	.177 (6.55)	.152 (4.06)	.052 (1.10)	.203 (3.90)
Secondary or More	.119 (14.83)	−.015 (1.79)	.104 (10.71)	.101 (7.93)	.009 (.54)	.110 (6.15)
Experience	.055 (10.50)	.042 (7.53)	.097 (15.29)	.049 (5.20)	.044 (3.72)	.092 (7.07)
Experience Squared ($x10^{-2}$)	−.084 (7.84)	−.051 (4.46)	−.135 (10.40)	−.067 (3.23)	−.083 (3.12)	−.151 (5.12)
Residual Disabled Day (Tobit)	−.019 (.43)	.123 (2.62)	.104 (1.94)	.036 (.89)	−.072 (1.42)	−.108 (1.91)

Table 13
Instrumental Variable Estimates of Wage, Hours and Earnings Equations with Morbidity Specified as a Tobit Model

Variables	Men			Women		
	Log Wage	Log Hours	Log Earnings	Log Wage	Log Hours	Log Earnings
Côte d'Ivoire						
Disabled Days	−.149 (2.55)	−.145 (2.88)	−.294 (3.67)	−.017 (.52)	−.046 (1.49)	−.062 (1.85)
Years of Schooling: Primary	.145 (10.04)	.015 (1.22)	.161 (8.10)	.111 (4.15)	.042 (1.67)	.152 (5.55)
Middle	.271 (12.88)	.016 (.90)	.287 (9.97)	.244 (7.54)	.066 (2.17)	.310 (9.28)
Secondary or More	.214 (14.18)	−.022 (1.67)	.192 (9.31)	.220 (9.38)	−.078 (3.53)	.142 (5.88)
Experience	.091 (9.64)	.034 (4.13)	.125 (9.63)	.052 (2.67)	.022 (1.21)	.074 (3.69)
Experience Squared ($x10^{-2}$)	−.079 (4.12)	−.040 (2.41)	−.119 (4.53)	−.040 (.92)	−.017 (.41)	−.057 (1.27)
Region: Other Urban	.171 (2.92)	−.056 (1.11)	.115 (1.44)	.100 (1.01)	−.086 (.92)	.015 (.14)
Forest East	.094 (.80)	−.349 (3.46)	−.255 (1.59)	−.266 (1.34)	−.573 (2.60)	−.840 (3.47)
Forest West	.239 (1.20)	−.439 (2.56)	−.201 (.74)	−.493 (.99)	−.418 (.89)	−.910 (1.77)
Savannah	.182 (.99)	−.249 (1.57)	−.067 (.26)	−	−	−
Constant	3.223 (22.03)	7.127 (56.63)	10.35 (51.69)	3.840 (15.11)	6.868 (28.71)	10.708 (40.82)
Sample Size	1452	1452	1452	376	376	376

Table 13 (continued)

Ghana						
Disabled Days	.018 (.42)	−.117 (2.34)	−.099 (1.79)	.046 (1.21)	.067 (1.38)	.114 (2.06)
Years of Schooling: Primary	−.012 (.69)	−.055 (2.65)	−.067 (2.95)	−.016 (.51)	.035 (.88)	.019 (.43)
Middle	.069 (3.10)	.108 (4.21)	.177 (6.28)	.153 (4.11)	.052 (1.08)	.204 (3.80)
Secondary or More	.119 (14.86)	−.015 (1.64)	.104 (10.27)	.101 (7.98)	.004 (3.68)	.110 (5.98)
Experience	.055 (10.53)	.042 (6.98)	.097 (14.67)	.049 (5.23)	.044 (3.68)	.092 (6.86)
Experience Squared ($x10^{-2}$)	−.084 (7.86)	−.051 (4.13)	−.001 (9.97)	−.068 (3.24)	−.083 (3.09)	−.151 (4.97)
Region: Coast Urban	.110 (1.74)	−.228 (2.37)	−.119 (1.49)	.031 (.29)	−.571 (4.10)	−.540 (3.43)
Coast Rural	.166 (1.61)	−.281 (2.37)	−.114 (.88)	.251 (1.38)	−.524 (2.26)	−.273 (1.05)
Forest Urban	.110 (1.93)	−.156 (2.42)	−.048 (.67)	.098 (1.01)	−.471 (3.81)	−.373 (2.67)
Forest Rural	.011 (.13)	−.189 (1.88)	−.178 (1.61)	.180 (1.12)	−.802 (3.90)	−.622 (2.67)
Savannah Urban	−.004 (.05)	−.491 (.85)	−.833 (.80)	.284 (2.10)	−.476 (2.74)	−.192 (.98)
Savannah Rural	.008 (.08)	−.020 (.16)	−.118 (.08)	.299 (1.35)	−.297 (1.05)_	.002 (.01)
Constant	2.700 (26.66)	6.95 (59.81)	9.65 (7.54)	2.507 (15.01)	6.528 (30.49)	0.035 (37.33)
Sample Size	1471	1471	1471	454	454	454

*Absolute value of the asymptotic t-ratios are in parenthesis.

productivity of the worker, but productivity provides the resources to invest in better nutrition and health care, and hence to produce better health (Strauss, 1986). The production of health and the effect of health on productivity must, therefore, be viewed in a simultaneous equation framework.

In addition to simultaneous equation bias, measurement error from self reporting of health status may be even more serious. It seems likely that simultaneous equation bias would lead to an overestimate by single equation methods of the effect of morbidity in a wage function, whereas in the most simple classical errors-in-variables framework the bias would be in the opposite direction, to underestimate the effect of morbidity as an explanatory variable. Because of the two potentially offsetting sources of bias, the direction of the net bias of an OLS estimate of the coefficient on the morbidity variable in a wage or labor productivity function cannot be deduced a priori (Griliches, 1977). Appendix Table A-3 reports the coefficients on observed disabled days in the wage participation probit equation, log wage, log hours and log earnings OLS equations which are potentially subject to simultaneous equation bias and errors in variables bias. The estimates are based as before only on wage earners, with or without a correction for sample selection of the wage earners, in the upper and lower panels of the table, respectively. A comparison of these estimates with those in Tables 7 through 10 will confirm that the estimated effects of morbidity on wage rates tend to be larger and negative in the consistent instrumental variable estimates than in the Probit/OLS estimates based on the observed morbidity. For example, in the case of men in Côte d'Ivoire, the OLS coefficient on log earnings is −.157 in Table A-3, whereas the comparable IV estimates in Table 7 is twice as large or −.290. This tentatively suggests that the bias due to measurement error is quantitatively more important in the case of health returns than that from the hypothesized source of simultaneous feedback.

Conditional on identification of the health and wage model outlined in this paper, the health variables are tested for their exogeneity in the wage function. The central problem for empirical study of the consequences of health for labor productivity is the choice of appropriate instrumental variables that account for a sufficient fraction of the variation in morbidity but are independent of individual preferences and exogenous health endowments, and thus do not affect health input behavior through their correlation with these background sources of heterogeneity in populations.

Is it reasonable to expect that variation in the time and money prices of health care, local health and transportation infrastructure, and food prices to provide an adequate basis for estimating the model outlined in this paper? We think it is, but are worried that the impact of these variables on morbidity and hence on productivity may operate in a highly nonlinear way among the poor, as confirmed by

Strauss (1986) in his study of the effect of available calories on the labor productivity of farm families in Sierra Leone. More controversial identifying variables may also be needed from within the intergenerational family itself. The education of a mother may noticeably affect the morbidity of her child, just as it affects the mortality of her children. The mother's and fathers education might be used, thus, as instrumental-variables determining their child's morbidity and physical growth, and thereby become a factor shaping the child's productivity as an adult, holding constant for traditional human capital variables such as schooling. This potential connection will be analyzed in future work.

We should be able to confirm within this model the endogeneity of disability in certain populations and then proceed to analyze public health or social welfare interventions that appear to be cost-effective means for reducing morbidity and thereby increasing labor productivity. Finding policy instruments that explain variation in measured health status is a challenge in many low income settings where the effectiveness of health care systems is in doubt, and there are few good measures of the quality and accessibility of health care services. The health economics literature reports few examples of health care interventions being strongly correlated with improved adult health status. The two confounding sources of parameter bias emphasized in this paper may account for this puzzling empirical finding.[11]

The second measurement issue emphasized in this paper is more amorphous: How to elicit from individuals in a household survey the most meaningful responses about their health status. Some regard self-reported health status as excessively subjective and readily modified by modernization and education and therefore not a useful indicator of medically defined morbidity (Johansson, 1991). In response to this concern, days of activity limitation were tabulated from parallel LSMS household surveys from Côte d'Ivoire and Ghana collected in the late 1980s. About one to four percent of persons report such an activity limitation in the last four weeks. About one day in those four weeks individuals did not engage in their usual activity because of illness. There is probably less of a financial penalty to miss a day's work when that work is performed in a family enterprise or as self-employed than as a wage earner. To reduce variation in the opportunity cost associated with reported activity limitation, the days of activity limitation are analyzed only for one group, namely, wage earners. Some evidence is reported that suggests this restriction of the health status measure yields an indicator that varies roughly in accord with mortality--higher for rural than urban areas, higher for preschool and elderly than for school aged and

[11]See footnote 4 for a further reason for finding no health care price effects on the demand for health services.

young adults, similar levels for men and women, and not strongly related to education. (cf. Tables 3, 4 and 5).

In order to better measure labor productivity and morbidity, the samples are restricted to men and women who hold a wage job as their primary employment. This sharply reduces the size of the working sample by 80 percent for males and by some 95 percent for females. Sample selection bias could be serious following such a procedure, and thus a probit function is specified to explain who is a wage earner. This is estimated jointly by maximum likelihood methods with the wage, labor supply, or earnings equations (Heckman, 1979; Greene, 1981). Although the sample selection correction equations appear to be reasonably identified, where land and wealth variables significantly reduce the likelihood that a man or woman is a wage earner, this correction procedure does not systematically change the effect of morbidity on worker productivity or labor supply.

The estimates for women in both countries are unrevealing, with some small signs of reduced wages and hours among women in Côte d'Ivoire who are more likely to experience morbidity. With only a few percent of the samples of adult women working in wage employment, and most of those employed in several major urban centers for which there is little variation in our measures of regional health infrastructure and food prices (the instrumental variables used here to predict morbidity), the female samples are ill designed to support the two-stage estimation methods proposed here. Indeed, the majority of the 4 percent of the Ivorian women who earn wages reside in one urban center, Abidijan.

The estimates for men are more informative. In Côte d'Ivoire, a reduction of one day inactivity per month due to illness is associated with a 29 percent increase in their annual wage earnings. About two-thirds of this effect of morbidity on earnings is associated with the worker's higher wage rate. For reasons discussed in the paper, the health effects on wage rates are more confidently interpreted than the effects on labor supply and earnings. In Ghana, on the other hand, the effect of a reduction of a day's inactivity is linked to a ten percent increase in hours, but has no statistically significant effect on wage rates. In both countries, men who are more likely to experience activity limitations are less likely to enter the wage labor force in the first place. Tobit estimates for morbidity and the corresponding two stage estimates of wage, hour and earning equations provide another alternative set of estimates that have common implications for the effects of morbidity on labor productivity.

Larger samples of wage earners and more focused questionnaires[12] should yield more precise estimates of the effects of adult morbidity on wage rates. It would then be appropriate to explore family labor supply relationships in which health indicators could be endogenized. The linkages between personal health and economic growth are both plausible and potentially important. They would seem to warrant far more study than they have received. This study confirms the productivity effects of health can be large, and the next step is to distinguish what variations in public policies or natural variations in environmental conditions combine to explain existing variation in adult morbidity among wage earners.

[12]The LSMS questionnaries could also be revised to clarify what economic penalty people incur to be "inactive" because of their illness, how individual daily wage rates compare to community standards, and how the qualities and quantities of health care vary across communities.

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Table A–1

Means and Standard Deviations of Variables for Alternative Samples in Côte d'Ivoire Age 15 to 65, Men and Women

Variables	Men		Women	
	All Persons	Wage Earners	All Persons	Wage Earners
Sample Size	7832	1452	9099	376
Dependent Variables				
Log Wage per Hour	—	5.99 (.124)	—	5.88 (1.19)
Log Hours per Year	—	7.46 (.745)	—	7.31 (.835)
Log Earnings per Year	—	13.5 (1.33)	—	13.2 (1.26)
Days Inactive Due to Illness in Past Four weeks	1.44 (4.71)	1.10 (3.70)		1.64 (4.96)
Predicted Days Inactive	1.35 (1.01)	1.10 (.689)	3.37 (5.51)	1.64 (1.56)
Independent Variables				
Years of Schooling:				
Primary	3.01 (2.89)	4.37 (2.58)	1.66 (2.59)	4.99 (2.19)
Middle	1.01 (1.61)	1.95 (1.90)	.408 (1.11)	2.29 (1.80)
Secondary	.327 (1.22)	1.06 (2.22)	.0891 (.661)	1.10 (2.44)
Post–Schooling Years of Experience	20.1 (16.1)	21.0 (11.8)	22.3 (15.1)	16.2 (9.64)
Household Assets:				
Business ($\times 10^{-6}$)	.565 (10.4)	.302 (.751)	1.15 (19.2)	.727 (9.32)
Value of Land ($\times 10^{-6}$)	5.02 (40.8)	.865 (.888)	5.50 (42.5)	2.06 (19.5)
Savings ($\times 10^{-6}$)	.497 (4.06)	.456 (2.87)	.435 (3.61)	.734 (1.45)
Unearned Income ($\times 10^{-6}$)	.176 (.724)	.156 (.636)	.176 (.721)	.387 (1.17)
Tontines ($\times 10^{-6}$)	.00442 (.0357)	.00768 (.0447)	.00454 (.0337)	.0186 (.0724)
Dowry ($\times 10^{-6}$)	.0479 (1.16)	.0434 (1.09)	.0341 (.866)	.148 (2.13)

Table A-1 (continued)

Community Cluster:				
Distance to Temporary Market in km	2.08 (4.60)	3.75 (2.16)	2.41 (4.96)	.128 (.911)
Distance the Closest to Hospital/Clinic in km		2.09 (9.50)		.684 (3.66)
Distance to the Closest Doctor/Nurse in km		1.38 (5.36)		.684[c] (3.66)
Region:[b]				
Forest East Rural	.182	.0592	.196	.0426
Forest West Rural	.126	.0193	.133	.00798
Savana Rural	.112	.0220	—[c]	—[c]
Other Urban	.315	.394	.296	.314
Rainfall (in mm/year)	109. (18.7)	115. (17.8)	108. (18.9)	118. (16.8)
Local Market Prices:				
Beef	.825 (.111)	.799 (.0865)	.823 (.116)	.793 (.0774)
Fish	.449 (.162)	.433 (.119)	.446 (.152)	.446 (.114)
Rice	.298 (.248)	.381 (.299)	.286 (.238)	.459 (.317)
Onions	.248 (.111)	.217 (.0935)	.250 (.107)	.206 (.0766)
Peanut Butter	.400 (.157)	.364 (.108)	.404 (.161)	.348 (.0771)
Palm Oil	.662 (.336)	.634 (.354)	.665 (.354)	.596 (.289)
Manioc	.0774 (.0461)	.0936 (.0473)	.0755 (.0465)	.106 (.0456)
Bananas	.0823 (.0395)	.0900 (.0368)	.0827 (.0390)	.0961 (.0368)

a. Standard deviation reported in parentheses beneath variable mean.

b. Standard deviation suppressed for dummy variables where it is = $\sqrt{M(1-M)}$, where M is the mean. Abidjan is the suppressed category.

c. Small population cell becomes empty in wage earner sample and suppressed in regressions for women, or perfectly co-linear with hospital/clinic.

Table A–2

Means and Standard Deviations of Variables for Alternative Samples in Ghana Age 15 to 65, Men and Women

	Men		Women	
Variables	All Persons	Wage Earners	All Persons	Wage Earner
Sample Size	5605	1471	6067	454
Dependent Variables				
Log Wage per Hour	—	3.68 (.889)	—	3.69 (.870)
Log Hours per Year	—	7.25 (.887)	—	6.97 (1.01)
Log Earnings per Year	—	10.9 (1.11)	—	10.7 (1.25)
Days Inactive Due to Illness in Past Four Weeks	1.25 (3.42)	1.08 (2.96)	1.32 (3.39)	1.24 (3.15)
Predicted Days Inactive	1.09 (1.00)	1.08 (.635)	1.52 (1.59)	1.24 (1.02)
Independent Variables				
Years of Schooling:				
Primary	4.15 (2.67)	4.94 (2.20)	2.87 (2.89)	5.05 (2.07)
Middle	2.16 (1.88)	2.93 (1.70)	1.31 (1.76)	2.94 (1.70)
Secondary	.689 (1.98)	1.38 (2.84)	.273 (1.26)	1.74 (3.12)
Post–Schooling Years of Experience	17.5 (15.3)	19.1 (13.0)	20.4 (15.5)	14.5 (10.5)
Household Assets:				
Business ($\times 10^{-6}$)	.0804 (2.52)	.00919 (.0550)	.0268 (.225)	.0205 (.111)
Value of Land ($\times 10^{-6}$)	.235 (1.19)	.109 (.583)	.230 (1.56)	.0821 (.486)
Savings ($\times 10^{-6}$)	.0278 (.296)	.0175 (.052)	.0183 (.0845)	.0234 (.0804)
Unearned Income ($\times 10^{-6}$)	.00278 (.0188)	.00390 (.0245)	.00334 (.0270)	.0397 (.0218)
Susu ($\times 10^{-6}$)	.0184 (.00848)	.00280 (.0100)	.00194 (.00859)	.0386 (.0115)
Dowry ($\times 10^{-6}$)	.00471 (.107)	.00431 (.0707)	.00599 (.0127)	.0268 (.339)
Community Cluster:				

Table A-2 (continued)

Distance to Temporary Market in Miles	2.99 (6.43)	1.48 (4.51)	2.99 (6.52)	1.30 (3.73)
Distance to the Closest Hospital/Clinic in Miles	4.06 (6.85)	1.68 (4.46)	3.89 (6.60)	1.13 (3.35)
Distance to the Closest Doctor/Nurse in Miles	3.67 (6.82)	1.42 (4.28)	3.50 (6.66)	1.13 (3.50)
Region:[b]				
Coast Urban	.121	.186	.138	.185
Coast Rural	.0833	.0503	.0773	.0463
Forest Urban	.216	.242	.228	.256
Forest Rural	.179	.0945	.167	.0617
Savannah Urban	.0824	.0816	.0849	.0947
Savannah Rural	.160	.0387	.157	.0286
Rainfall (in mm/year)	49.9 (14.2)	46.2 (16.0)	49.9 (14.0)	45.1 (16.0)
Local Market prices:				
Eggs	24.3 (3.51)	25.6 (3.06)	24.3 (3.64)	25.8 (3.46)
Fish	525. (118.)	529. (109.)	523. (120.)	523. (123.)
Maize	61.7 (8.90)	63.6 (7.89)	61.8 (8.93)	63.4 (8.67)
Onions	373. (128.)	376. (125.)	375. (128.)	360. (110.)
Peanuts	148. (24.6)	151. (22.7)	147. (24.7)	152. (24.5)
Palm Oil	177. (41.2)	189. (40.2)	176. (40.1)	191. (41.4)
Cassava	26.7 (4.91)	27.7 (4.42)	26.7 (5.05)	27.7 (4.59)
Bananas	48.0 (16.6)	48.6 (15.2)	47.7 (17.0)	48.0 (17.0)
Tomatoes	681. (59.0)	691. (57.2)	684. (61.0)	690. (63.9)
Sugar	153. (18.8)	155. (17.3)	153. (19.8)	155. (17.2)
Nivaquine	4.15 (.561)	4.20 (.516)	4.14 (.560)	4.18 (.542)

Table A-2 (continued)

Local Health Problem:				
Malaria	.430	.241	.436	.264
Diarrhea	.158	.0911	.171	.141
Water Sanitation and Transportation	.188	.0965	.175	.112
Anti-Malaria Campaign in Last 5 Years	.287	.177	.294	.178
State Level Public Health Expenditures Appropriated per Person in 1987:				
Preventive Services	91.6 (20.9)	91.1 (17.6)	91.6 (22.0)	89.5 (16.0)
Curative Services	220. (78.7)	242. (80.3)	218. (79.4)	246. (79.4)

a. Standard deviation reported in parentheses beneath variable mean.

b. Standard deviation suppressed for dummy variables where it is equal to $\sqrt{M(1-M)}$, where M is the mean. Abidjan is the suppressed category.

c. Small population cell becomes empty in wage earner sample and suppressed in regressions for women, or perfectly co-linear with hospital/clinic.

Table A–3

Coefficients on Actual Days Inactive Due to Illness in Wage Participation, Wage, Hours and Earnings Equations[a]

Country, Estimation Method, Sex and Sample size	Wage Participation (1)	log Wage (2)	log Hours (3)	log Earnings (4)
Côte d'Ivoire				
With Sample Selection Correction–Maximum Likelihood:				
Men (7832/1452)	–.00986 (2.03)	–.00297 (.49)	–.129 (3.11)	–.157 (3.06)
Women (9099/376)	.00187 (.29)	–.00562 (.71)	–.0105 (1.22)	–.0250 (3.04)
Without Selection Correction–Ordinary Least Squares:				
Men (1452)	—	–.00458 (.75)	–.132 (2.56)	–.178 (2.66)
Women (376)	—	–.00582 (.65)	–.0194 (2.33)	–.0252 (2.79)
Ghana				
With Sample Selection Correction–Maximum Likelihood				
Men (5605/1471)	–.0154 (2.38)	–.00121 (.14)	.00978 (1.05)	.00294 (.26)
Women (6067/454)	–.00450 (.53)	.0136 (.83)	.00197 (.09)	.0156 (.64)
Without Selection Correction–Ordinary Least Squares:				
Men (1471)	—	–.00024 (.03)	.00288 (.38)	.00264 (.31)
Women (454)	—	.0136 (1.19)	.00191 (.13)	.0155 (.96)

a. Beneath coefficient in parenthesis is t statistic. Participation as wage earner is estimated in probit form jointly with wage rate, and coefficients are reported in column (1).

Table A–4

Ordinary Least Squares Estimates of Number of Days Ill and Inactive in the Last Four Weeks Used to Instrument Days Inactive in Tables 7, 8, and 9.

Explanatory Variables	Côte d'Iviore		Ghana	
	Men	Women	Men	Women
Years of Schooling: Primary	.006 (.11)	.108 (.65)	−.079 (1.17)	.023 (.17)
Middle	−.007 (.10)	−.055 (.27)	.043 (.52)	−.031 (.20)
Secondary or more	−.059 (1.09)	−.205 (1.51)	−.018 (.60)	.099 (1.81)
Post−schooling Experience	−.016 (.47)	−.119 (1.05)	.027 (1.36)	.014 (.37)
Experience Squared ($\times 10^2$)	.086 (1.27)	.277 (1.07)	−.030 (.75)	−.018 (.21)
Household Assets (x10^{6}) Business	.024 (1.77)	−.030 (.87)	−.003 (.002)	−1.37 (.84)
Value Land	.001 (.05)	.000 (.01)	.017 (.13)	−.164 (.52)
Savings	−.030 (.85)	.325 (1.47)	−2.12 (1.22)	6.04 (2.77)
Unearned Income	.254 (1.45)	.443 (1.6)	5.65 (1.71)	−10.3 (1.44)
Tontines/Susu	−2.02 (.93)	−2.20 (.62)	2.34 (.30)	−5.09 (.38)
Dowry	−.154 (1.49)	−.123 (.77)	−.529 (.48)	−.114 (.25)
Community Cluster: Distance to Market (km)	−.049 (.69)	.104 (.19)	−.026 (1.10)	.069 (1.15)
Distance to Dr./Nurse (km)	.037 (1.26)	.191 (.94)	−.007 (.27)	.078 (1.36)
Rainfall (mm/yr)	−.014 (1.42)	−.019 (.51)	−.002 (.16)	.040 (1.65)

Table A-4 (continued)

Explanatory Variables	Côte d'Iviore		Ghana	
	Men	Women	Men	Women
Region:				
Forest E/Coast Rural	−.721 (.85)	−1.62 (.34)	.419 (.61)	1.02 (.75)
Forest W/Forest Rural	−1.25 (1.06)	−4.99 (.64)	1.57 (2.39)	.526 (.36)
Savanna Rural	−1.82 (1.62)	*	−.138 (.84)	−.770 (.44)
Other Urban/Coast Urban	−.034 (.06)	−.488 (.26)	.501 (1.15)	.556 (.65)
Other Urban/Forest Urban	−	−	.451 (.82)	.622 (1.18)
Other Urban/Savanah Urban	−	−	.126 (.20)	−.142 (.11)
Prices:				
Beef/Eggs	−.568 (1.80)	−3.43 (.55)	.023 (.65)	.016 (.27)
Fish	−.182 (1.02)	−1.34 (.67)	.001 (.47)	.002 (.67)
Rice/Maize	−.277 (.53)	1.27 (1.53)	.000 (0.00)	−.028 (1.16)
Onions	−.383 (1.30)	3.55 (.41)	−.001 (.81)	.003 (1.41)
Peanut Butter	3.40 (1.08)	4.96 (.24)	.002 (.37)	.001 (.12)
Palm Oil	.423 (.31)	−.081 (.94)	−.004 (1.37)	.002 (.26)
Manioc/Cassava	3.08 (3.11)	3.97 (.64)	.025 (1.07)	.097 (2.12)
Bananas	−5.73 (2.95)	−12.2 (.14)	.009 (1.14)	−.012 (.84)
Tomatoes	−	−	.001 (.46)	−.003 (.84)
Sugar	−	−	−.09 (1.46)	−.009 (.66)
Antibiotic	−	−	.245 (1.49)	−.741 (2.08)

Table A-4 (continued)

Explanatory Variables	Côte d'Iviore		Ghana	
	Men	Women	Men	Women
Province Public Expenditures Per Capita: Preventive Health	–	–	.012 (1.13)	.023 (.97)
Curative Health	–	–	.002 (.81)	–.005 (.73)
Community Health Problems: Malaria	.788 (.64)	4.71 (1.76)	.624 (1.44)	–.176 (.19)
Diahrrea	.915 (.84)	–.372 (.70)	–.351 (.95)	1.58 (2.05)
Measles and Chicken Pox	.170 (.20)	–4.46 (1.21)	–.032 (.10)	–.636 (.95)
Water–Sanitary/Water Transportation	.068 (.07)	1.33 (.30)	.066 (.19)	.726 (1.11)
Malaria Eradication Campaign in last 5 years	–	–	–.378 (1.04)	.101 (.15)
Immunization Campaign in last 5 years	–	–	.175 (.36)	–.207 (.20)
Constant	2.73 (1.71)	5.48 (1.03)	–2.51 (.98)	5.23 (.95)
Standard Error of Regression	3.68	4.90	2.94	3.13
R^2	.034	.100	.046	.101
Sample Size	1452	376	1471	454
Mean of Dependent Variable (SD)	1.10 (3.70)	1.64 (4.96)	1.08 (2.96)	1.24 (3.15)

*no observations in cell.